

METEORITE WIS91600: A NEW SAMPLE RELATED TO A D- OR T-TYPE ASTEROID. T. Hiroi¹, E. Tonui², C. M. Pieters¹, M. E. Zolensky³, Y. Ueda⁴, M. Miyamoto⁴, and S. Sasaki^{4,5}, ¹Dpt. of Geological Sci., Brown University, Providence, RI 02912 (takahiro_hiroi@brown.edu), ²Dpt. of Earth and Space Sci., University of California Los Angeles, 595 Charles Young Drive East, Los Angeles, CA 90095-1567, ³SN2, NASA Johnson Space Center, Houston, TX 77058, ⁴Dpt. of Earth and Planetary Sci., University of Tokyo, Hongo, Tokyo 113-0033, Japan, ⁵National Astronomical Observatory of Japan, 2-21-1 Osawa, Mitaka, Tokyo 181-8588, Japan.

Introduction: Since the Tagish Lake meteorite fell in January 2000, the assumed one-of-the-kind meteorite has become the hottest issue among a diversity of scientists. Meanwhile, as the physical origin of the meteorite in our solar system, D or T asteroids have been suggested by Hiroi *et al.* [1, 2] based on comparison of their visible-near-infrared (VNIR) reflectance spectra. While it is probably still true that the Tagish Lake meteorite is possibly the first recovered sample from a D or T asteroid as a meteorite fall, we report in this paper that the meteorite WIS91600 may actually be the first recovered sample from one of those asteroids as a meteorite find.

Data Source and Experimental Procedure: VNIR reflectance spectra of T and D type asteroids [3-5] have been averaged. The 3- μm spectral data for asteroids 511, 308, and 773 were taken from [6-8]. Asteroid 511 Davida is classified as C type, 308 Polyxo as T or D type, and 773 Irmtraud as D type [9-10]. Bidirectional VNIR reflectance spectrum (0.3-2.6 μm) and off-axis biconical FT-IR spectrum (1.7-25 μm) of the Tagish Lake sample (ground powder of <125 μm) were taken from [2]. Same spectral measurements have been performed for a similarly prepared sample of WIS91600. In addition, off-axis biconical FT-IR spectra of samples of CI1 chondrite Orgueil (<100 μm) and CM2 chondrite Murchison (<63 μm) have been measured for comparison.

Asteroid-Meteorite Connection: VNIR reflectance spectra of the Tagish Lake and WIS91600 samples are compared with the T/D asteroid average spectrum in Fig. 1. They are scaled to fit with one another in the visible wavelength range. The WIS91600 sample shows an even more similar VNIR spectrum to the average T/D asteroid spectrum than the Tagish Lake sample. Spectral variation among individual T/D asteroids and viewing geometry effects are shown in [1-2], which does not seem to change this conclusion.

The 3- μm hydration band features of WIS91600 and Tagish Lake are compared with those of asteroids 511 Davida, 308 Polyxo, and 773 Irmtraud in Fig. 2. Tagish Lake shows a 3- μm band feature which is consistent with a C asteroid 511 Davida but different from a D asteroid 773 Irmtraud. On the contrary, in the VNIR range, Tagish Lake is similar to D/T asteroids but different from C asteroids.

On the other hand, WIS91600 shows a very similar 3- μm feature to a T/D-type asteroid 308 Polyxo, if one peculiar data point of Polyxo at 3.5 μm can be disregarded and its VNIR spectrum shows a near-perfect match with the average T/D asteroid spectrum as shown in Fig. 1. The VNIR spectrum, especially its continuum slope, is believed to be strongly affected by the amount of carbon and other opaque phase, while the 3- μm band feature shows characteristics of the component hydrous minerals.

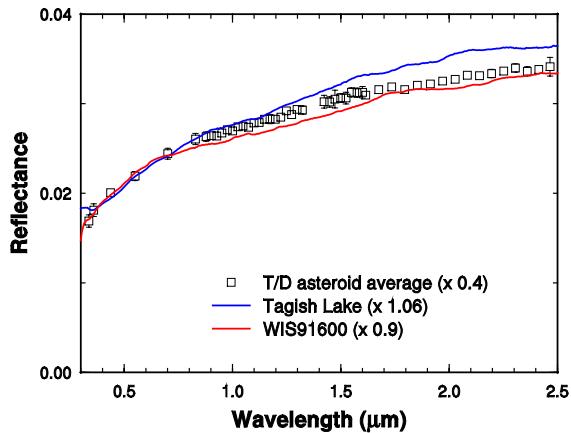


Fig. 1. Bidirectional visible-nearIR reflectance spectra of Tagish Lake and WIS91600 meteorite samples (<125 μm) in comparison with the average telescopic spectrum of the T/D asteroids [3-5].

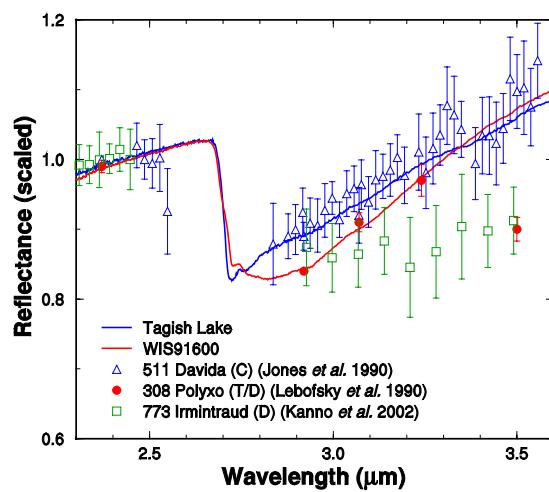


Fig. 2. Off-axis biconical reflectance spectra of Tagish Lake and WIS91600 meteorite samples (<125 μm) in comparison with the 3- μm telescopic spectra of asteroids 511, 308, and 773 [6-8]. Reflectance values are normalized at around 2.45 μm in wavelength.

WIS91600: A NEW SAMPLE RELATED TO A D- OR T-TYPE ASTEROID : T. Hiroi *et al.***Characterization of the 3- μ m Band Feature:**

What is the relationship of the Tagish Lake and WIS91600 meteorites with common CI and CM chondrites from the viewpoint of the 3- μ m band features? In order to compare the characteristics of the 3- μ m band due to hydrous mineral components, the 3- μ m reflectance spectra of these two meteorite samples and Orgueil (CI1) and Murchison (CM2) samples have been processed as follows. Natural log of each reflectance spectrum in the wavelength range of 2.6-4.1 μ m was calculated, a linear continuum which contacts with the natural log spectrum at around 2.65 and 4.1 μ m was subtracted from the spectrum, and the obtained continuum-removed spectrum was normalized to -1 at the wavelength of 2.9 μ m. The results are shown in Fig. 3.

As seen in Fig. 3a, at first glance WIS91600 looks similar to Orgueil in overall 3- μ m band shape, while WIS91600 shows almost exactly the same spectrum with Tagish Lake from 2.9 to 3.3 μ m. On the other hand, if we pay attention to only the existence of individual bands, disregarding their relative strengths, as indicated in Figs. 3a and 3b, we can obtain a comparison result summarized in Table 1. WIS91600 shares many absorption bands with Tagish Lake and some with Orgueil. The 2.71, 2.72, and 2.724 μ m bands are so close to one another that they may be due to the same kind of hydrous mineral with different compositions. Concerning those features, Tagish Lake seems to show a combination of WIS91600 and Orgueil. Whereas a more quantitative analysis is definitely needed to characterize the 3- μ m hydration bands of these meteorite samples, WIS91600 is surely not an ordinary CM chondrite such as Murchison [11]. It is likely that WIS91600 have many hydrous component minerals with Tagish Lake and some with Orgueil.

Table 1. Comparison of 3- μ m Band Features of Tagish Lake, WIS91600, Orgueil (CI1), and Murchison (CM2) Samples.

Sample	Estimated band center wavelength (μ m)						
	2.71	2.72	2.724	2.77	2.82	2.94	3.13
Tagish Lake	?	?	Y	Y	Y	Y	Y
WIS91600			Y	Y	Y	Y	Y
Orgueil	Y				Y	Y	Y
Murchison		Y					

Summary: We have newly identified the meteorite WIS91600 as another possible sample from a D- or T-type asteroid. Reflectance spectral analysis suggests that WIS91600 and Tagish Lake have similar carbon content and kinds of hydrous minerals, part of which are shared by Orgueil (CI1) meteorite. WIS91600 and Tagish Lake may represent a variety in composition and/or the degree of aqueous alteration among the D- and T-type asteroids.

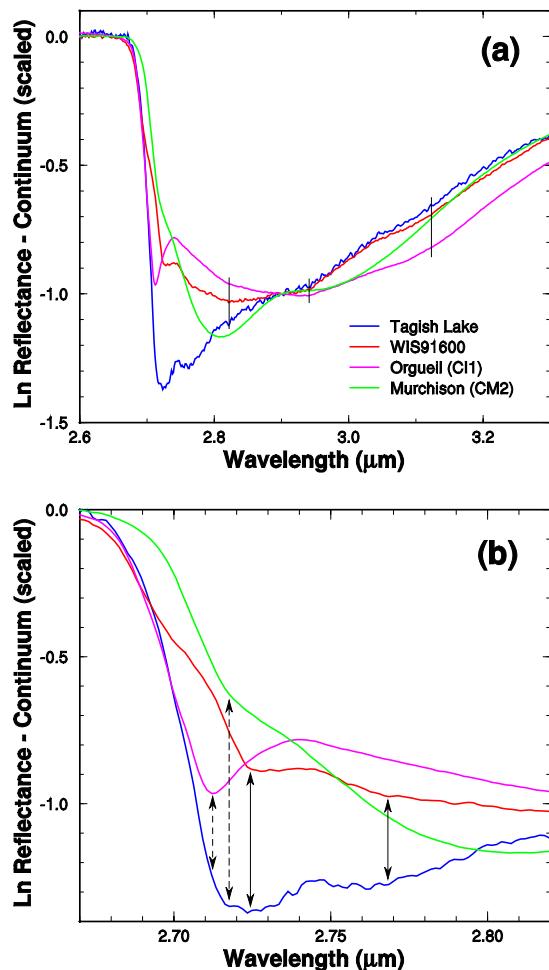


Fig. 3. Continuum-removed and scaled natural logarithm reflectance spectra spectra of Tagish Lake, WIS91600, Orgueil (CI1), and Murchison (CM2) meteorite samples. (b) is an expanded view of (a). Each line or arrow indicates similar absorption band features among different meteorite samples.

Acknowledgment: Authors appreciate NSF and Meteorite Working Group for the WIS91600 meteorite sample. Reflectance spectra of the meteorite samples were measured at RELAB, a multiuser facility operated under NASA grant NAG5-13609. A part of this research was supported by NASA grant NAG5-12847 to TH.

References: [1] Hiroi T. *et al.* (2001) *Science*, 293, 2234. [2] Hiroi T. and Hasegawa S. (2003) *Antarct. Meteorite Res.*, 16, 176. [3] Zellner B. *et al.* (1985) *Icarus*, 61, 335. [4] Chapman C. R. and Gaffey M. J. (1979) In *Asteroids*, Univ. Arizona Press, 1064. [5] Bell J. F. *et al.* (1989) *Lunar Planet. Sci.*, 19, 57. [6] Lebofsky L. *et al.* (1990) *Icarus*, 83, 16. [7] Jones T. D. *et al.* (1990) *Icarus*, 88, 172. [8] Kanno A. *et al.* (2002) *Proc. 35th ISAS Lunar Planet. Sci.*, 154. [9] Tholen D. J. (1984) Ph.D. thesis, Univ. Arizona. [10] Barucci M. A. *et al.* (1987) *Icarus*, 72, 304. [11] Bearly A. (2004) *Lunar Planet. Sci.*, 35, Abstract #1358.